which it flows, while at the same time a record is made of the volume of the fluid thus displaced.

The more important work going on in the laboratory at the time of my visit consisted of experiments in regard to respiration, with special reference to the functions of the glottis and epiglottis, and trials of disinfectants with a view to ascertaining the temperature necessary to kill germs. A series of experiments was also in progress for testing the porosity of various stones used in building.

The results of the original work performed here have been recently published, together with an account of the physical apparatus in use at the school. Accounts of the most important investigations carried on during the last year are contained in the following papers: "Growth as a Function of Cells: Preliminary Notice of Certain Laws of Histological Differentiation," by C. G. Minot; "Effects of the Respiratory Movements on the Pulmonary Circulation," by H. P. Bowditch, M. D., and G. M. Garland, M. D.; "Pharyngeal Respiration," by G. M. Garland, M. D.; "Functions of the Epiglottis in Deglutition and Phonation," by G. L. Walton. This paper shows that the removal of the epiglottis does not seriously affect deglutition, and therefore it is not necessary for that process. The epiglottis, however, plays an important part in forming and modifying the voice, taking different positions during vocalization, changes of pitch, quality, and intensity.

In the chemical laboratory I found that Professor Wood had been examining the water-supply of Cambridge; and was then engaged in the investigation of the extent to which arsenic is being used in the manufacture or ornamentation of articles in general use, such as wall-paper, confectionery, playthings, etc. The results of this work will be published in the next report of the State Board of Health. Professor Wood is also writing the addition to "Ziemssen's Cyclopædia" on the subject of toxicology.

Dr. William B. Hills was engaged upon a special investigation in regard to the localization of arsenic in the animal economy.

The most important feature of original work at the school of late years has been Dr. Bigelow's introduction of the new operation of litholapaxy.

A number of interesting papers have been recently written by members of the faculty, some of which contain new discoveries of considerable scientific importance. I cite two: "Effects of Certain Drugs in increasing or diminishing Red Blood-Corpuscles," by Dr. Cutter; and "Alterations in Spinal Cord in Hydrophobia," by Dr. Fitz.

The School of Agriculture and Horticulture, called "The Bussey Institution," is located on the sunny slopes of Forest Hills, about five miles southwest from Boston. The labors of the professors connected with this institution have been even more in the line of original research than of instruction, though of late the lack of a sufficient endowment has interfered with the quality of work and the publication of the results.

A number of exceedingly interesting and valuable papers, however, have appeared in the "Bussey Bulletin," the titles of which give some indication of the character of the work. I give a few of the more important: "Hybridiza- of Lilies," by Professor Parkman; "Diseases caused by Fungi"—Professor Farlow; Examinations of Fodders," "Trials of Fertilizers," "Prominence of Carbonate of Lime in Soil-Water," "Importance as Plant-Food of the Nitrogen in Vegetable Mold"—Professor F. H. Storer; "The Potato-Rot," and "The Black Knot" (of plum and cherry-trees)—Professor Farlow.—*Popular Science Monthly.*

ON THE EFFECTS PRODUCED BY MIXING WHITE WITH COLORED LIGHT.

It was noticed several years ago that when white light was mixed by the method of rotating discs with light of an ultramarine (artificial) hue, the result was not what one would naturally have expected, viz.: instead of obtaining a lighter or paler tint of violet-blue the color inclined decidedly toward violet, passing, when much white was added, into a pale violet hue. Two attempts have been made to account for this curious fact: Brücke supposes that the light which we call white is really to a considerable extent red, and that the mixture of this reddish white light with the blue causes it to change to violet. Aubert, on the other hand, following a suggestion of Helmholtz, reaches the conclusion that violet is really only a lighter shade of ultramarine-blue. He starts with the assumption that we obtain our idea of blue mixed with white from the sky, which, according to him, is of a greenish-blue color. We then apply, as he thinks, this idea to the case of a blue which is not greenish, namely, to ultramarine-blue, and are surprised to find that the result is different.

It will be shown in the present paper that these explanations are hardly correct, since they fail to account for the changes, which, according to my experiments, are produced in other colors by an admixture of white. I prepared a set of brilliantly colored circular discs which represented all the principal colors of the spectrum and also purple; these discs were then successively combined in various proportions with a white disc and the effects of rapid rotation noted, a smaller duplicate colored disc uncombined with white being used for comparison. Under these circumstances it was found that the addition of white produced the changes indicated in the following table:

Vermilion became somewhat purplish.
Orange became more red.
Yellow became more orange.
Greenish yellow was unchanged.
Yellowish green became more green.
Green became more blue-green.
Cyan-blue became less greenish, more bluish.
Cobalt-blue became more of a violet blue.
Ultramarine (artificial) became more violet.
Purple became less red, more violet.

Exactly these same effects can be produced by mixing violet with the above mentioned colors. These experiments serve to explain the singular circumstance that when complementary colors are produced by the aid of polarized light, it is difficult or impossible to obtain a red which is entirely free from a purplish hue, a quantity of white light being always necessarily mingled with the colored light. In the case of the red, orange, yellow, ultramarine, and purple discs, I succeeded in measuring the amount of violet light which different proportions of the white disc virtually added to the mixture, and found that it is not directly proportional to the amount of white light added, but increased in a slower ratio, which at present has not been accurately determined.

For the explanation of the above mentioned phenomena, Brücke's suggestion that white light contains a certain amount of un-neutralized red light is evidently inapplicable, since the effects are such as would be produced by adding a quantity not of red but of *violet* light, and for the present I am not disposed to assume that white light contains an excess of violet light. The explanation offered by Aubert does not undertake to account for the changes produced in colors other than ultramarine, and even in this case seems to me arbitrary; neither have I succeeded in framing any explanation in accordance with the theory of Young and Helmholtz which seems plausible.—PROF. O. N. ROOD, *American Journal of Science*

BERNARDINITE: ITS NATURE AND ORIGIN.

By J. M. STILLMAN.

In a previous number of this Journal[1] I published the results of a chemical investigation of a resinous substance from San Bernardino, sent to me by Hon. B. B. Redding, which was said to occur in the form of vein in detached masses, and the vein to be traceable for three miles. The finders (farmers or "ranchers" of that vicinity) sent at the same time pieces of rock as vein-stuff which contained this peculiar resinous substance in the crevices. Some months later

[1] III, vol. xviii, p. 57.

another specimen was sent to this University from Santa Aña in the same section of the country by a resident who stated in his letter that on throwing a match upon the ground he was surprised to see these rocks take fire and burn. He therefore sent a piece to be examined.

The specimens furnished to Mr. Redding were examined by me and the result published in the above mentioned article. The substance, which was extremely light, white and porous, almost chalky, was shown to be mainly a well-marked resin, leaving but a trace of an ash on combustion. No theory was advanced as to its origin, and attention was called simply to its structure :—" On fracture it presents a slightly fibrous structure. Under the microscope it exhibits a two-fold structure—a quantity of very fine, irregular fibers permeating a mass of a brittle, amorphous, structureless substance." Since that paper was written I have endeavored to obtain more definite information as to the origin and occurrence of this peculiar substance. The region of its occurrence is so remote and so inaccessible that it has been impossible for me to investigate the matter in person, and difficult to find competent persons whose business takes them into that region. However, from reports obtained through the agency of Mr. Redding, I feel tolerably confident that the true nature and origin of this substance has been cleared up.

It seems that there grows, and probably has grown for a long time, a species of conifer which exudes large masses of a resinous secretion from abrasions or wounds. These resinous masses are reported to attain considerable size, and to fall off from their own weight. However that may be, the detached resin either from fallen and decayed trees, or from living trees, becomes scattered over the surface of the country and mixed with surface soil and rocks. By a long process of evaporation, action of atmosphere, and the leeching and bleaching agency of the snow which covers the ground for a large portion of the year, these resinous masses lose all vestiges of volatile and soluble matter, and at the same time a fungus growth permeates and splinters the whole mass into minute fragments rendered coherent by the fibers of the fungus. Hence the two-fold structure noted, the fungus growth as shown in the previous paper, amounting to less than 10 per cent of the mass.

The perfect change which has taken place in the resin by these agencies evidence that the resin must have been exposed for an indefinite period to atmospheric agencies, and have attained a position of equilibrium toward its surrounding conditions. It is therefore apparently entirely a surface formation, which however has in process of time become so mixed in with surface soil and rocks as in some instances to present the appearance of being *in situ*. (*American Journal of Science*.)

UNIVERSITY OF CALIFORNIA, May, 1880.

EDUCATION OF YOUNG ASTRONOMERS.

France has of late shown a greatly increased activity in astronomical work, both in the improvement of existing, and the institution of new, observatories. The question of how to provide these with men thoroughly competent to carry on the work has come prominently forward.

Hitherto, the recruiting of the observatories has taken place in the most irregular manner, and without the help of any special schools, such as are provided for other scientific careers. The candidates who have presented themselves have often neither possessed the theoretical knowledge, nor the ardor and special aptitude necessary for a career so difficult.

At the Paris Observatory, where the staff is the most numerous, and the *matériel* of instruments most complete, a certain amount of practical instruction could be given, but this only at the expense of the ordinary service, and through the goodwill of the older officials, whose regulations did not comprise this surplus work.

But in provincial observatories education has been more difficult, if not impossible. From lack of funds, it is unfortunately often the astronomical professor of the local faculty who is also director of the observatory, and he has to divide his time between these two functions. Sometimes, too, this director, an excellent professor of mathematics and celestial mechanics, has not been sufficiently initiated in the practice of the very delicate observations of astronomy requiring much experience and skill. Lastly, the *matériel* of these observatories has remained hitherto in a state of regretable inferiority, which could hardly inspire the observers with zeal. It will be readily understood, then, how the number of astronomical observers has been very limited, to the prejudice of astronomical work and discovery in France. This is the more regretted since that country has not been wanting in great geometers, who have remarkably promoted the arduous science of celestial mechanics; the illustrious names of Laplace and Leverrier will here readily occur.

It was, then, an urgent matter to form as soon as possible a superior school of practical astronomy, and with this view a ministerial decree has recently been promulgated. With candidates carefully selected and instructed for some time in a systematic way under masters of the science, a number of able astronomers may be looked for, competent to make a good use of the excellent instruments and opportunities that are now being plentifully provided.

The duration of the studies (to be carried on in Paris) will be two years. The first year will be chiefly devoted to the theoretical and practical study of the meridian service, the fundamental base of the astronomy of observation, and to the use of portable instruments, comprising those with reflection, for it is necessary that every astronomer in an observatory should be capable of teaching the use of instruments employed in traveling, and methods of observation, to the explorers, now so numerous, who, on leaving, seek preparatory instruction, the determination of latitudes and longitudes, &c., in the course of their travels. The second year will be devoted to service of equatorials and physical astronomy. The first half of each year will be occupied in lectures, studies, and exercises. During the second half, the students will make the regular service of observations along with the officials of the observatory.

The lectures will be as follows: During the first year, theory of the meridian service, by M. Loewy; practice of meridian observations, by M. Périgaud; calculations of spherical astronomy, by M. Gaillot; use of portable instruments, by M. Mouchez. During the second year, physical astronomy, equatorials, and physics of the globe, by M. Wolf; applied celestial mechanics, by M. Tisserand.

Moreover, MM. Jamin and Desains, the eminent professors of the Sorbonne, will open their physical laboratories to the young astronomers, and direct them in their studies and the management of instruments and various experiments which may interest them, and facilitate their labors in physical astronomy. M. Mascart, director of the central meteorological office, will also put them *au courant* with recent progress accomplished by meteorological science and service.

The work and lectures will be arranged so as to allow the students to attend other courses at the College of France and of the Sorbonne, having some direct relation to astronomy, or capable of being useful to them for obtaining university diplomas.

THE science of human life has been the last to recognize that minute interaction of all the sciences which every other department of knowledge now readily admits. We allow at once that no man can be a good physiologist unless he posesses a previous acquaintance with anatomy and chemistry. The chemist, in turn, must know something of physics, while the physicist cannot move a step until he calls in the mathematician to his aid. Astronomy long appeared to be an isolated study, requiring nothing more than geometrical or arithmetical skill; but spectrum analysis has lately shown us its intimate interdependence upon chemistry and experimental physics. Thus, the whole circle of the sciences has become a continuous chain of cycles and epicycles, rather than a simple sequence of unconnected and independent principles.—PROF. GRANT ALLEN, *Popular Science Monthly*.